REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT #: AFRL-RHD-27-14

# Data-Driven Predictive Modeling of Trajectories Under Directed Energy Visual Bioeffects

**PROJECT DESCRIPTION:** Virtual reality (VR) flight simulators utilizing platforms such as Unity, Unreal Engine, and Advanced Framework for Simulation Integration and Modeling (AFSIM) provide essential environments for educating and evaluating pilots under simulated directed energy (DE) conditions, including laser dazzle and flashblindness. While pilot flight path data from these visual disruption events have been collected, conducting exhaustive parameter sweeps across every potential laser hazard, ambient condition, and flight maneuver remains resource-intensive.

This project aims to bridge that gap by developing a lightweight, data-driven machine learning (ML) framework to model decision-making from existing flight path data. As an ORISE participant, you will analyze historical trajectory datasets from simulated encounters, preprocess state-action features, and train predictive models to emulate pilot control strategies during these events. By integrating these predictive agent models back into the simulation workflow, the team can rapidly predict responses and deviations across unseen hazard parameters without requiring continuous, full-scale human-in-the-loop testing.

This research directly supports 6.3 research objectives by enhancing predictive threat assessment capabilities and optimizing future protocols for directed energy environments.

**LEARNING OBJECTIVES:** Under the guidance of a mentor, you will gain hands-on experience to complement your education and support your academic and professional goals. Along the way, you will engage in activities and research in several areas, including but not limited to:

1. Learn to ingest, clean, and extract state-space feature sets from time-series flight telemetry data generated across simulation engines, including Unity, Unreal Engine, and AFSIM.
2. Gain practical experience applying predictive machine learning and artificial intelligence (ML/AI) techniques to capture dynamic human decision-making and control responses under environmental constraints.
3. Develop a fundamental understanding of how directed energy bioeffects, such as glare, dazzle, and flashblindness, impact pilot visual performance, spatial orientation, and operational decision-making.
4. Practice integrating ML pipeline outputs back into defense-relevant simulation frameworks.
5. Develop experience communicating technical findings to a multidisciplinary research team.

**ACADEMIC LEVEL:** Undergraduate**,** Master's, Doctoral
**DISCIPLINES NEEDED:** Computer Science, Engineering (Aerospace), Data Science
**RESEARCH LOCATION:** JBSA Fort Sam Houston, Texas
**RESEARCH MENTOR:** Clint Lanham
Master's of Science in Physics, Virginia Tech, 2023

*The material was CLEARED on 19 Oct 2026; Case Number: AFRL-2026-1821*



Clint Lanham is a research physicist in the Air Force Research Laboratory's Optical Radiation Branch (711 HPW/RHDO). In his current role, he works on the Bioeffects Division's modeling and simulation team, applying his computation and theory background as a subject matter expert, scoping new research initiatives, and leading technical discussions to develop physics-based projects and implement component library integration towards directed energy risk assessments. Prior to his work with the Air Force, Clint was a Health Physicist at UCLA, where he managed comprehensive radiation safety programs for university facilities. His research background is rooted in nuclear, particle, and condensed matter physics, with a focus on data analysis, physics-based modeling, and Monte Carlo simulations. His current research areas include modeling high-energy laser-particle interactions, condensed matter theory for advanced protective equipment, reflectance modeling for vision effects, and digital engineering.

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